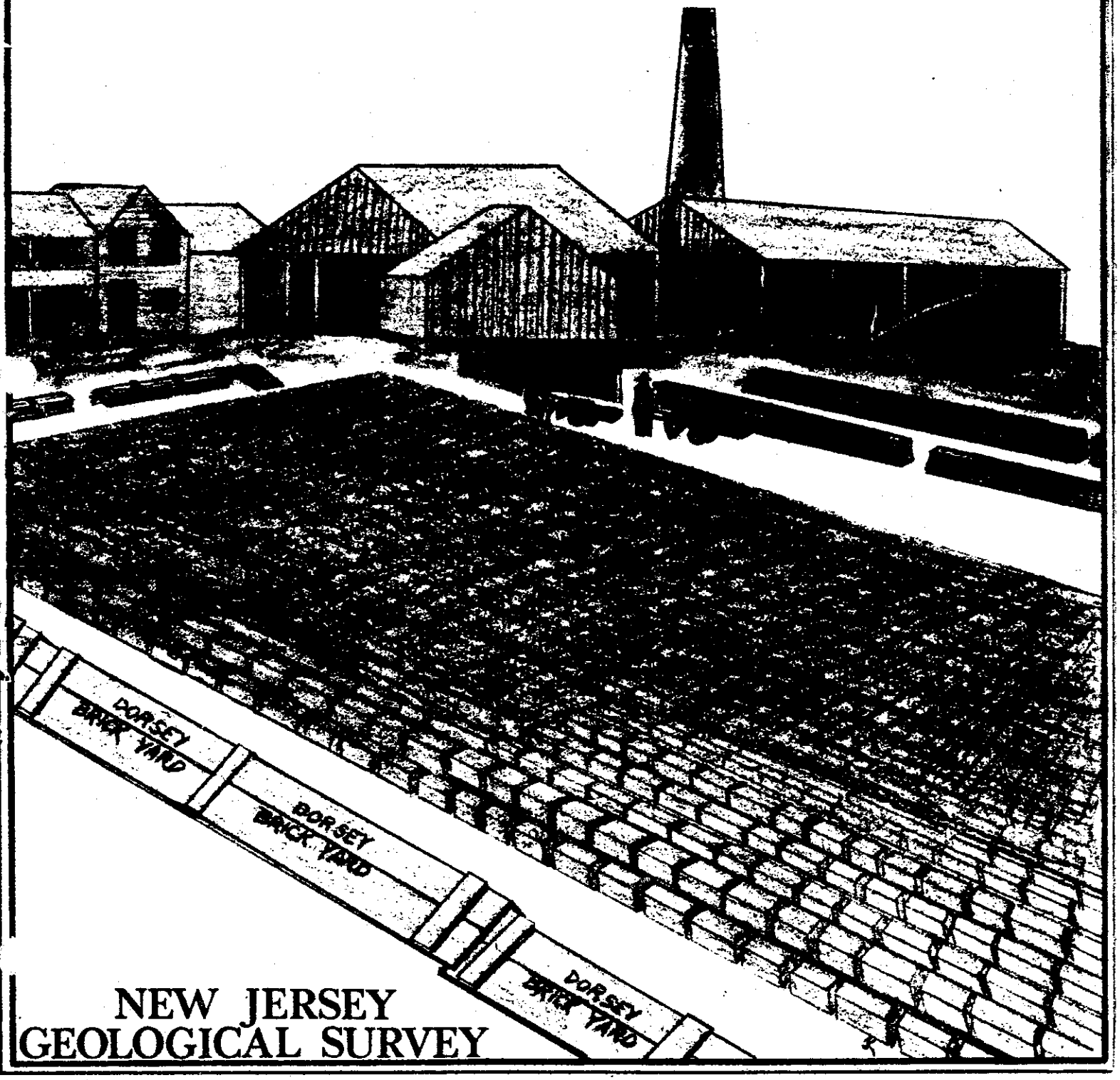
GEOLOGY
OF
MIDDLESEX COUNTY
IN BRIEF



NEW JERSEY
GEOLOGICAL SURVEY

STATE OF NEW JERSEY

Department of Environmental Protection
Jerry Fitzgerald English, Commissioner

Division of Water Resources
Arnold Schiffman, Director

New Jersey Geological Survey
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GEOLOGY OF MIDDLESEX COUNTY

by

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December, 1980

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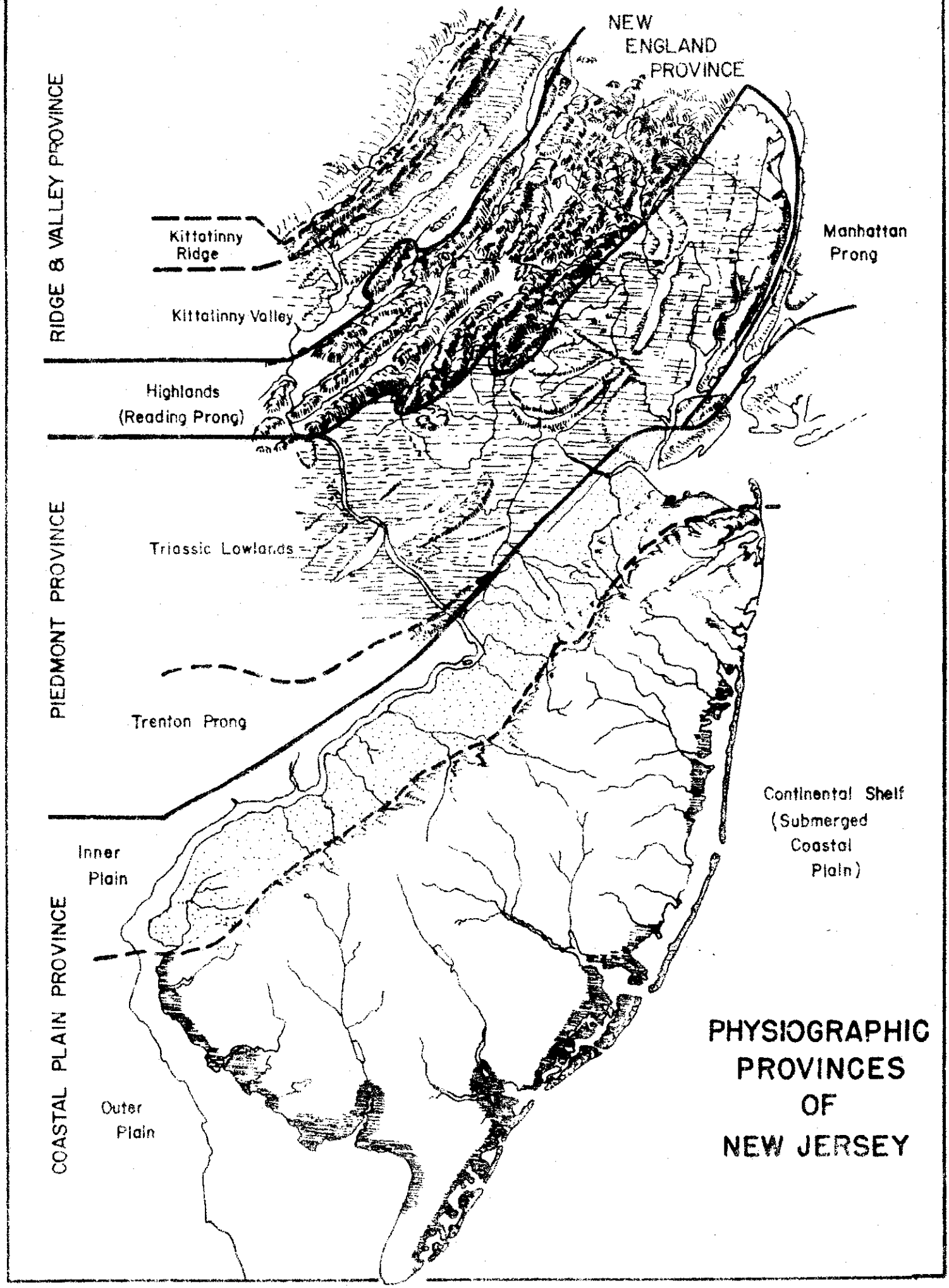

NEW
ENGLAND
PROVINCE
RIDGE & VALLEY PROVINCE
Kittatinny
Ridge
Kittatinny Valley
Manhattan
Prong
Highlands
(Reading Prong)
PIEDMONT PROVINCE
Triassic Lowlands
Trenton Prong
Continental Shelf
(Submerged
Coastal
Plain)
Inner
Plain
COASTAL PLAIN PROVINCE
Outer
Plain
PHYSIOGRAPHIC
PROVINCES
OF
NEW JERSEY

GEOLOGY OF MIDDLESEX COUNTY IN BRIEF

Topography and Geomorphology

The southeastern two thirds of Middlesex County lies in the Inner Lowland section of the Coastal Plain Province; the remainder is within the Newark Basin of the Piedmont Physiographic Province (see map). The northeastern portion of the county has been modified by continental glaciers which extended as far south as South Plainfield, Metuchen, and Perth Amboy.

The Coastal Plain area is very flat or gently rolling. Steeper slopes and as much as 150 feet of relief form narrow valleys where streams and rivers have entrenched this surface. Occasionally, slopes are steepened by iron cemented sands which form near the crest of the slopes.

The Piedmont section of the county is also flat but has a more rolling topography and is more deeply dissected by numerous streams. Northwest and northeast of Deans a diabase intrusion, "traprock," which is more resistant to erosion than the soft red shale which underlies most of the Middlesex County Piedmont, forms the Sand Hills, Little Rocky Hill, and Rocky Hill. The name "Sand Hills" comes from the iron cemented sands, the last remnants of a once more extensive deposit of uncertain age, which are protected from erosion by the above-mentioned diabase or traprock ridge.

The northeastern corner or glaciated portion of the county is marked by the terminal moraine, a one to two mile wide ridge of boulders, gravel, sand and clays carried southward by moving ice and deposited at the southern margin of the continental ice sheet. This terminal moraine, rising 100 to 150 feet above its surroundings, is pockmarked with numerous depressions, some are now ponds, resulting from the melting of blocks of ice trapped in the heterogenous sediments of the moraine. Meltwater carrying sand and gravel southwestward from the ice front deposited an "outwash plain" of sands and

gravels which forms the Plainfields.

Geologic History

Precambrian Era

Precambrian time is about 85 percent of geologic history. The complex history of this long span of time can only be partially deciphered from Precambrian rocks found elsewhere. Life had its origin and some very primitive forms may have flourished toward the close of this era more than 600,000,000 years before the present. No rocks of Precambrian age outcrop within the county. Deep wells have penetrated hard crystalline schists which may be Precambrian. Similar rocks undoubtedly form much of the basement on which the Coastal Plain sediments were deposited.

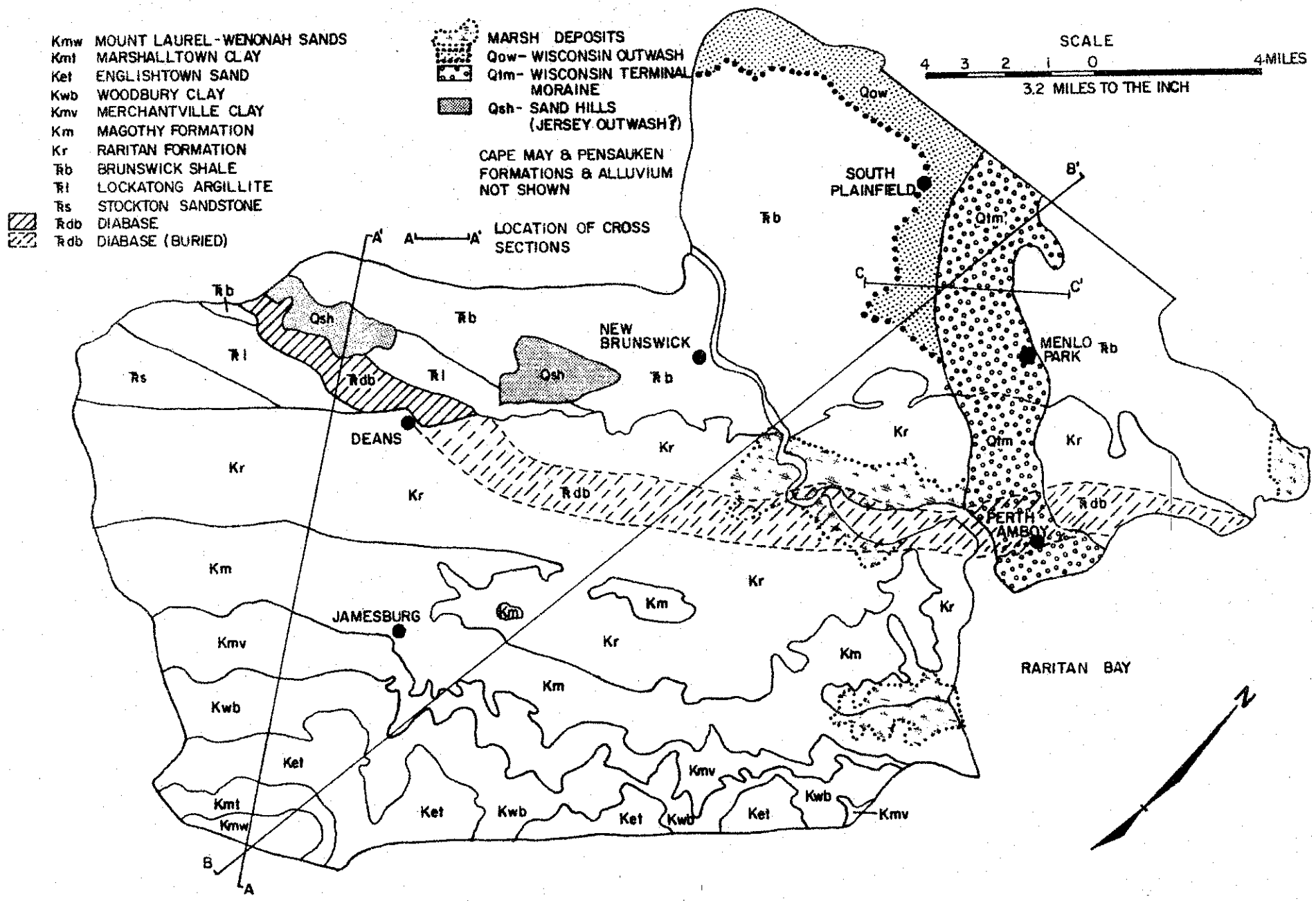
Paleozoic Era

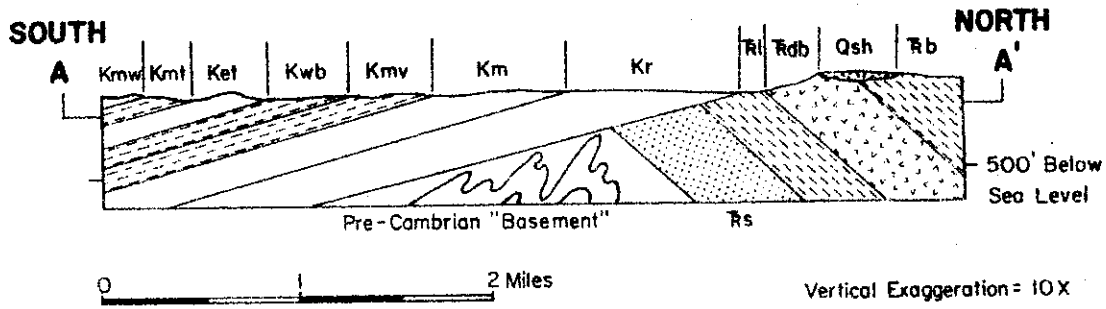
No Paleozoic rocks are known in Middlesex County. A nearly complete sequence, however, occurs in Sussex and Warren Counties. Rocks of this era may be fossilferous, hence the name Paleozoic, meaning dawn of life. There were several mountain building movements of the earth's crust during this period which resulted in intense folding and some metamorphism of rocks belonging to this era. Metamorphosed Paleozoic rocks underlie Manhattan Island and much of New England.

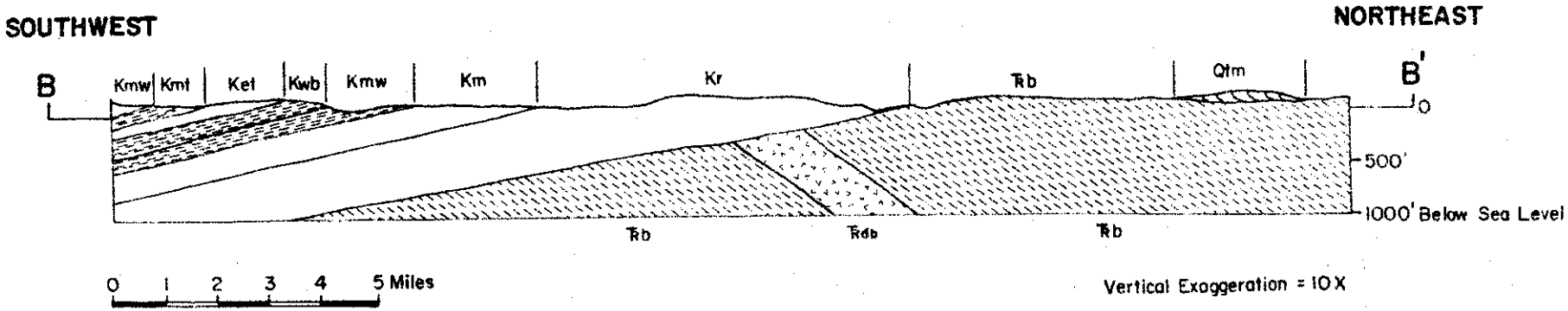
Mesozoic Era

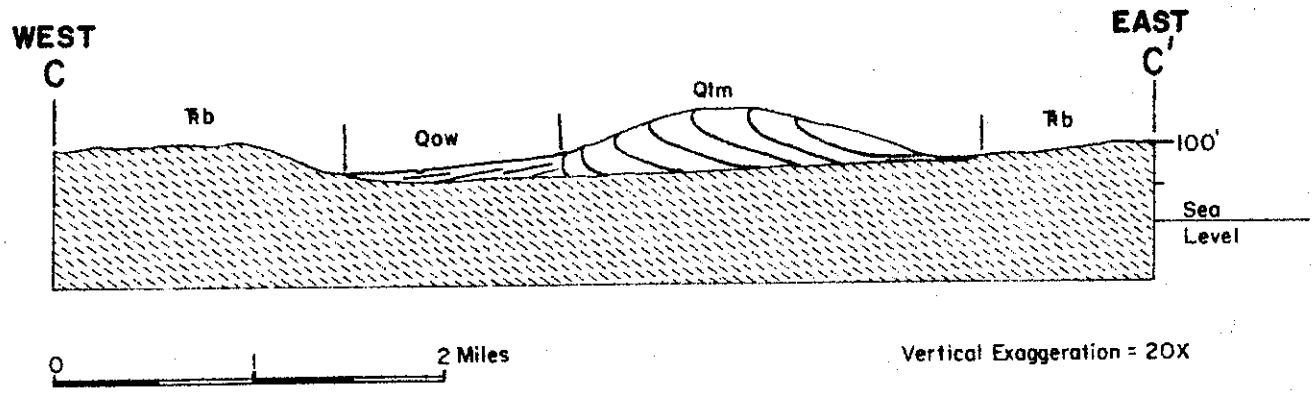
Triassic Period - Middlesex County and much of the eastern seaboard were above sea level during Triassic and Jurassic times. North America, Africa and Europe formed one continent, but the crust was beginning to break apart into the several plates which now form the continents. Great faults broke New Jersey into block mountains and rift valleys, much like those of the present day Africa. Seasonal streams brought sand, silt, gravel and mud from the mountains into the valleys. The sands deposited

GEOLOGIC MAP OF MIDDLESEX COUNTY









GEOLOGIC CROSS SECTIONS

by these streams eventually became lithified forming the Stockton sandstone, a light tan or pink to reddish brown rock containing an abundance of feldspar grains. Feldspar weathers quickly and disintegrates in a humid climate. This indicates very arid climatic conditions during which playa lakes formed in low lying parts of the basin. Mud cracks and raindrop impressions found preserved in the Lockatong argillite indicate that the muds which accumulated on the bottoms of these lakes were frequently exposed as the lakes dried up. At the edge of the deep fault or rift valleys the streams deposited coarse gravels, but further out in the valley alluvial fans became fine sand or clay. The clay deposits of the alluvial fans in contrast to those in the playa lakes are known as the Brunswick Formation.

Unless one remembers to consider the origin of the sediments, the early Mesozoic, Triassic, and Jurassic sediments can be confused. Many of the older text books and some carelessly written references referred to these sediments, the Stockton, Lockatong and Brunswick, as a stratigraphic succession. The sequence is not clear-cut and the formations interfinger with each other. Sometimes all three formations were being deposited at the same time. This is particularly true with respect to deposition of the Brunswick shale and the Lockatong argillite. The latter, because of their chemical composition, are resistant to weathering and are suitable for building stone. The Brunswick shales were deposited during wet periods when the great valleys had external drainage flowing to the sea.

During the deposition of the Triassic sediments there were three outpourings of basalt lava from the northwest side of the rift valleys. These lava flows remain now as the Watchung Mountains. Not all the molten basaltic rock reached the surface. Some of it forced its way between layers

of sediment to form a sheet-like body of intrusive igneous rock called diabase (also called traprock). This mass of diabase, the Palisades sill, stretches from Haverstraw, New York, to south of Hopewell Borough in Mercer County. It underlies Little Rocky Hill in Middlesex County. This intrusion is buried beneath later sediments from Deans, southwest of the City of New Brunswick, northward to the northwest part of Staten Island, where it is again found at the surface forming the southern extension of the Palisades. Boulders of this rock were found at the base of the Sayer and Fisher clay pit on Raritan Bay and in the foundations of the bridge between Perth Amboy and South Amboy. Water wells some miles south of New Brunswick also encountered this rock at depth. Unlike the Watchungs, this intrusion probably originated along the eastern border of the rift valley.

Diabase, the intrusive rock, and basalt, the extrusive lava, are identical in chemical and mineral composition. However, since the diabase was intruded beneath the surface it cooled much more slowly than the basalt and the various minerals had a chance to grow larger crystals. This was particularly true of the feldspar, the lighter crystals, which causes a difference in color and established a network of interlocking crystals which makes the diabase a tougher, more durable rock than the basalt for such uses as highway pavement.

Jurassic Period - Recent studies giving more precise dates for parts of Mesozoic history and the New Jersey Piedmont indicate that the uppermost (youngest) beds of the Brunswick Formation and the basalt lava flows of the 2nd Watchung may have been deposited during the early Jurassic Period. In New Jersey the exact boundary between the Triassic and Jurassic rocks has not been established. There is apparently no break in the continuous deposition of sediments. In the early days of geologic study, the New Jersey Mesozoic

rocks were classified as Jurassic. However, fossil vertebrates found in the lower part of the sequence indicate a Triassic age. No fossil vertebrates have been found in the Triassic sediments of Middlesex County.

After the Triassic and Jurassic sediments were deposited there was a crustal movement which resulted in a reversal of dip or tilt. Rocks that were originally deposited in nearly horizontal beds dipping to the south are now seen to dip about 15° northwestward.

Following the deposition of the sediments and the igneous activity of Triassic and Lower Jurassic age there was a long period of continuous erosion during which all of New Jersey was leveled to almost a plain, a peneplain, with very low relief and streams many miles apart. This flat surface was the Fall Zone Peneplain which extends under the present Coastal Plain sediments. Subsequent to this long period of static crust, northern New Jersey was uplifted while southern New Jersey was depressed.

Late Jurassic and Early Cretaceous - The present topography reflects the removal of the more easily eroded rocks such as limestones and shales or the more shattered and jointed rocks along fault zones. The crystalline rocks, basalt and diabase, being less easily weathered stand as ridges. To a lesser extent, the argillite and conglomerate of the alluvial fans form less pronounced hills giving central Middlesex County its rolling terrain.

Cretaceous Period - As the Fall Zone Peneplain subsided beneath the cretaceous seas a succession of sands and clays were deposited on a new coastal plain and the offshore sea bottom. During Cretaceous times the land rose and subsided several times in relation to the sea level, changing the depositional environment and location of the seashore.

The Raritan Formation was first to be deposited. Its sediments of sands and clays reflect an environment of flood plains and deltas of major rivers.

Carbonized wood (lignite) and other land plant fossils as well as brackish water clams are found in this formation.

As southern New Jersey sank beneath the sea, sands and clays were deposited in bays and other shallow marine areas to become the Magothy Formation. Some marine fossils have been found. The overlying Merchantville Formation formed with interstratified glauconitic sands and thin beds of clayey silt, indicating a deeper water (offshore) marine environment.

The dark gray clay of the Woodbury Formation was deposited on top of the Merchantville. The lack of glauconite indicates deposition in shallower water than the Merchantville and signifies the first of several up and down movements of what is now the New Jersey Coastal Plain. As the water became even shallower, white to yellow quartz sands and some clay layers were deposited to form the Englishtown Formation.

A subsidence of the coast followed as indicated by the dark gray to black silty glauconitic sands of the Marshalltown Formation. The overlying medium-fine grained sands contain mica flakes and some glauconite of the Wenonah sands were deposited in deeper water.

The next formation, the Mount Laurel, is so similar to the Wenonah that they are grouped together, but the Mount Laurel becomes coarser toward the top where occasional pebbles may be seen, which indicates that the subsidence which began with the Wenonah Formation was short-lived and the sea floor was beginning to rise. The deposition of the sediments of the Mount Laurel would indicate that the sediments were deposited closer to shore in shallower water.

The Mesozoic Era was the age of the dinosaurs. Dinosaur footprints have been found in the Brunswick Formation and in the clays of the Raritan Formation. Several skeletons have been found in the Mesozoic rocks of New

Jersey, but none have been found in Middlesex County.

Cenozoic Era

Tertiary Period - There are no Tertiary sediments in Middlesex County, but the history of a rising and falling ocean bottom, or sea level, continued in the Tertiary Period of the Cenozoic Era to the south and east of Middlesex County. The Tertiary Formations suggest that, at times, the ancient New Jersey shore was well up into what is now north Jersey, while during the late Tertiary, the shore line may have been far off to the east of the present coast.

Quarternary Period -

The Ice Ages - At least four times during the last million years of the Cenozoic Era great icecaps spread southward from snow fields in Canada, covering much of the northern United States with an ice sheet up to two miles thick. The last of these, the Wisconsin sheet, just barely reached Middlesex County, and deposited a terminal moraine of boulders and mud carried southward and released from the glacial ice as it melted. As indicated earlier in the section on topography, this moraine now stands as a broad ridge stretching from the Plainfields through Metuchen to Perth Amboy. As the ice melted, great torrents of water deposited sand and mud in front of the moraine, forming a broad outwash plain.

The Sand Hills deposit in South Brunswick Township is shown on the State Geologic Map as an outlier or erosional remnant of the Raritan Formation, but since it is separated from the other unconsolidated formations of the Coastal Plain it may belong to one or another of the Cretaceous or Tertiary Formations. The late Joseph Miller*, while investigating gas pipeline excavations to the north of Sand Hills uncovered evidence of many glaciated striated pebbles and some lake clays. This would suggest that the very earliest

Pleistocene glaciation may have extended as far south as the north side of the Sand Hills.

Between the glacial stages the rivers and streams eroded the abundant supply of sand and gravel left behind by the retreating glaciers and redeposited them along their courses. These deposits, the Pensauken and Cape May Formations, veneer part of the Piedmont and most of the Coastal Plain of Middlesex County.

Recent - Beach sands, stream sands and gravel, marsh deposits and soil make up the youngest geologic deposits in the county.

*Unpublished work of the Late Joseph W. Miller, Jr.

MINERAL RESOURCES AND HISTORY

Ground Water

Although usually overlooked in resource lists, water is an indispensable natural resource.

Middlesex County has abundant but not unlimited ground water supplies. Heavy pumpage by industry and municipal wells have lowered water levels in several areas within the county. One crisis was averted when competing companies pooled their resources and created Duhernal Lake (Duhernal is an acronym for Dupont, Hercules and National Lead). This raised the water table levels, providing adequate water for each company as well as for the surrounding communities. Since then, Perth Amboy and Sayreville have each constructed similar artificial recharge lakes adjacent to their well fields.

Sand and Gravel

Sand and gravel pits are located at various places in the county. The abundance of sand in several geologic formations provides for local demand. Large pits in East Brunswick and South River were established to take advantage of thick gravel deposits adjacent to water transport. Railroads and trucks now do much of the shipment. The Pensauken gravels have been completely stripped in many places, with some pits extending deep into the Raritan Formation.

Clays and Related Products

The Clay District of Middlesex County was once world famous for its several varieties of clay. All that remains today of this once thriving industry of clay production is one small active clay pit and one refractory clay operation.

In the 1870's, clay pits stretched from South River through Sayreville to South Amboy. A few more were scattered southward as far as Tennents Pond.

North of the Raritan River most of the clay operations clustered around Woodbridge and the area south of Fords. Additional pits dotted the district as far west as Martins Dock.

All the important clays were taken from the Raritan Formation. Although the Raritan Formation is mainly sand, several clay layers are found within it. Each layer produced its own particular type of clay. Some merely produced common brick clays, others fire clays - among the finest in the world. Stoneware and pottery clays were fashioned into common and fine pottery. Miscellaneous clay products from tiles to sanitary fixtures were produced in great abundance.

Interbedded with the clays was a high-grade fire sand useful in making refractory bricks. Lignite (brown coal) found in some beds was mined for a short while but this soon proved impractical because of the small quantity and poor burning characteristics.

Copper

The various copper mines of the state have generally been disappointing failures. The three occurrences in Middlesex County were no exception.

The French Mine in New Brunswick was started after copper was discovered (in 1748) on the farm of Phillip French. The two hundred pounds of copper found while plowing fields raised high hopes. Shafts up to 60 feet deep and tunnels that extended several hundred feet under the Raritan River were allegedly constructed. Many tons of ore were reportedly shipped to England, but the mine closed down in failure.

The Raritan Mine, three miles southwest of New Brunswick, was originally worked prior to 1840, then sold to a new operator in 1847 after which it apparently failed. The main shaft is said to be 160 feet deep.

The Menlo Park (Edison) Mine was briefly operated shortly after copper

was discovered about 1784. Renewed exploration and reopening was attempted in 1812, 1827 and in the 1880's by Thomas Edison, and finally again in 1903. No ore was ever shipped. The deepest shaft is said to be 120 feet deep.

GEOLOGIC TIME SCALE

Geologic time intervals are unequal subdivisions of the earth's history corresponding to earth's geologic events. Eras are the longest divisions of time and contain many periods which are further subdivided into epochs. Formations, which are mappable units of rock or sediments, usually have lithology or characteristic distinctions and are assigned to that period or epoch during which they are formed.

A formation's place within the stratigraphic column is determined by the predominant form of life preserved as fossils within the rocks or sediments. If fossils are lacking, a formation's location in the time scale may be determined by its relationship to previously dated units. Only recently have geologists been able to place an absolute date on these relative time units by radioactive methods.

The geologic column is used throughout the world, although some regional modifications may be used for greater clarity.

In the accompanying stratigraphic column, the rock type given after the name is the most common variety found in the county. There may be variation of lithology within the formation from place to place.

GEOLOGIC TIME SCALE OF MIDDLESEX COUNTY

Era	Period	Epoch	Formation and Approximate Thickness	Approx. Age Million Years before Present
CENOZOIC	Quaternary	Recent Pleistocene	Soil Alluvium (10-50') Marsh deposits (0-50') Ice-borne glacial deposits: Terminal moraine (80-150') Ground moraine or till (0-10') Water-borne glacial sediment: Outwash, including Sand Hills sediments (10-60') Cape May gravels (0-30') -Not shown Pensauken gravels (0-70')- on map	0-1
	Tertiary	Pliocene Miocene Oligocene Eocene Paleocene	Not present in county	1-70
MESOZOIC	Cretaceous		Mt.Laurel-Wenonah sands (50') Marshalltown clays (40') Englishtown sands (100') Woodbury clays (50') Merchantville clays (55') Magothy sands (90') Raritan sands and clays (200')	70-135
	Jurassic - - - ? - - - ? - - - ? - Triassic		Palisades diabase (850') Brunswick shale (6,000') Lockatong argillite (3,500') Stockton sandstone (2,500')	135-180 - - - ? - - - ? - - 180-255
PALEOZOIC	Permian) Penn.) Carboniferous) Miss.) Devonian) Silurian) Ordividian) Cambrian		Not present in state Not present in county	225-600
PRECAM-BRIAN			Crystalline "Basement"	600+

Dashed lines indicate formation being deposited in two time periods.

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BOOKS OF INTEREST AVAILABLE FROM THE NEW JERSEY GEOLOGICAL SURVEY

County Series:

Geology of Atlantic County in Brief; Brenda Jogan, Asst.Geologist
Geology of Bergen County in Brief; Carol S. Lucey, Sr.Geologist
Geology of Burlington County in Brief; K. Widmer and C. S. Lucey
Geology of Essex & Union Counties in Brief; C. S. Lucey, Sr.Geologist
Geology of Hunterdon County in Brief; Carol S. Lucey, Sr.Geologist
Geology of Mercer County in Brief; Kemble Widmer, State Geologist
Geology of Monmouth County in Brief; Paul B. Dahlgren, Sr.Geologist
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Geology of Somerset County in Brief; Debra Tobiassen, Asst.Geologist
Geology of Sussex County in Brief; Carol S. Lucey, Sr.Geologist
Geology of Warren County in Brief; Carol S. Lucey, Sr.Geologist

COVER: Dorsey Brick Yard, South River. Rows of bricks are seen in the foreground sun drying prior to being kilned. (From a 1901 photograph redrawn by John Kremper.)